

FIG.1

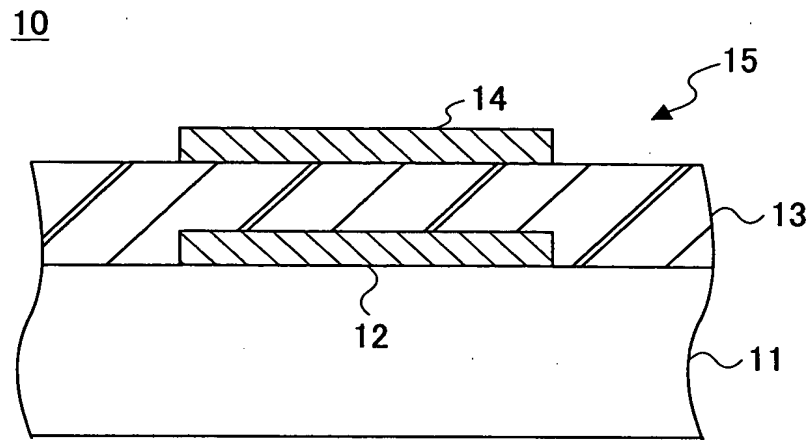


FIG.2

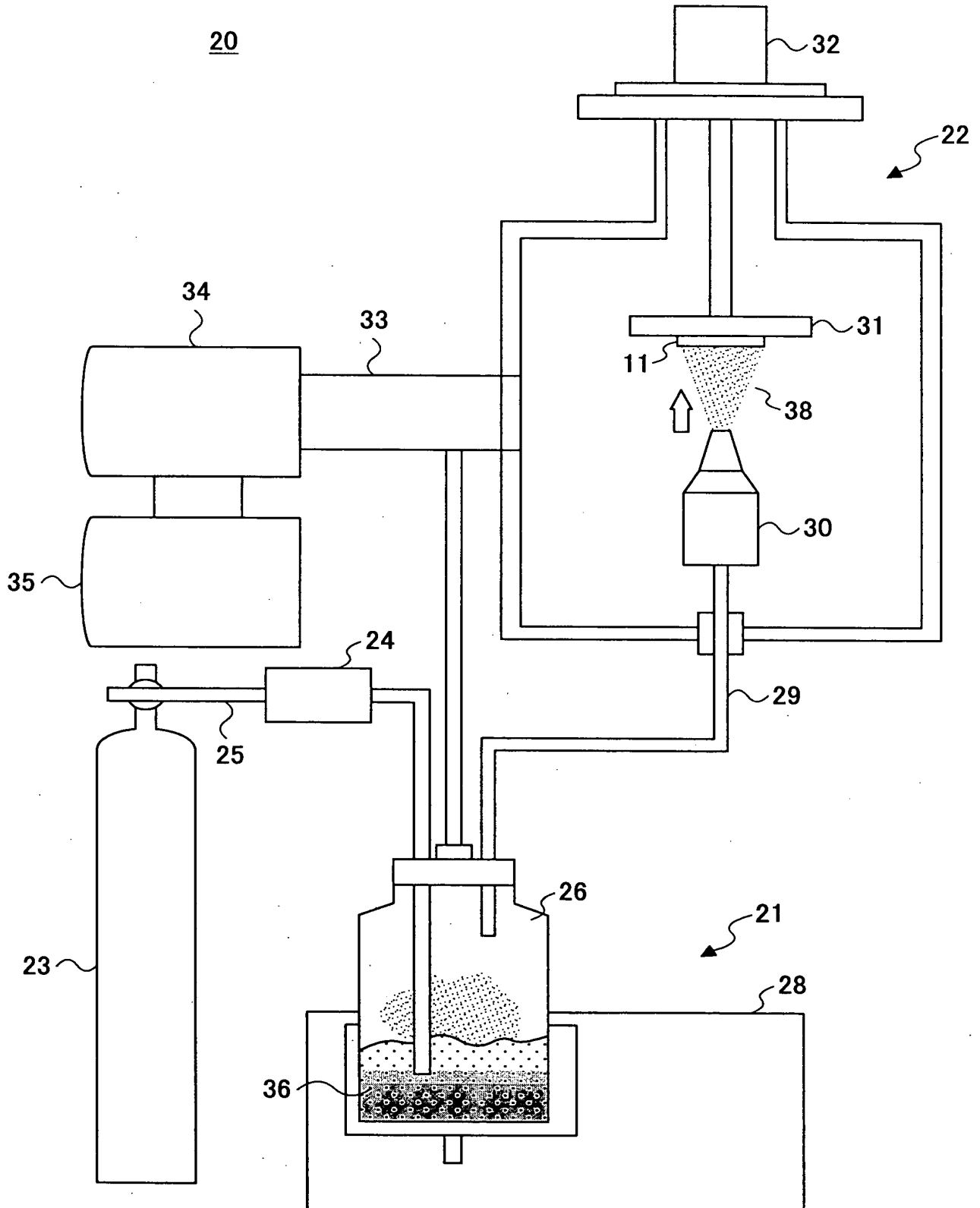


FIG.3

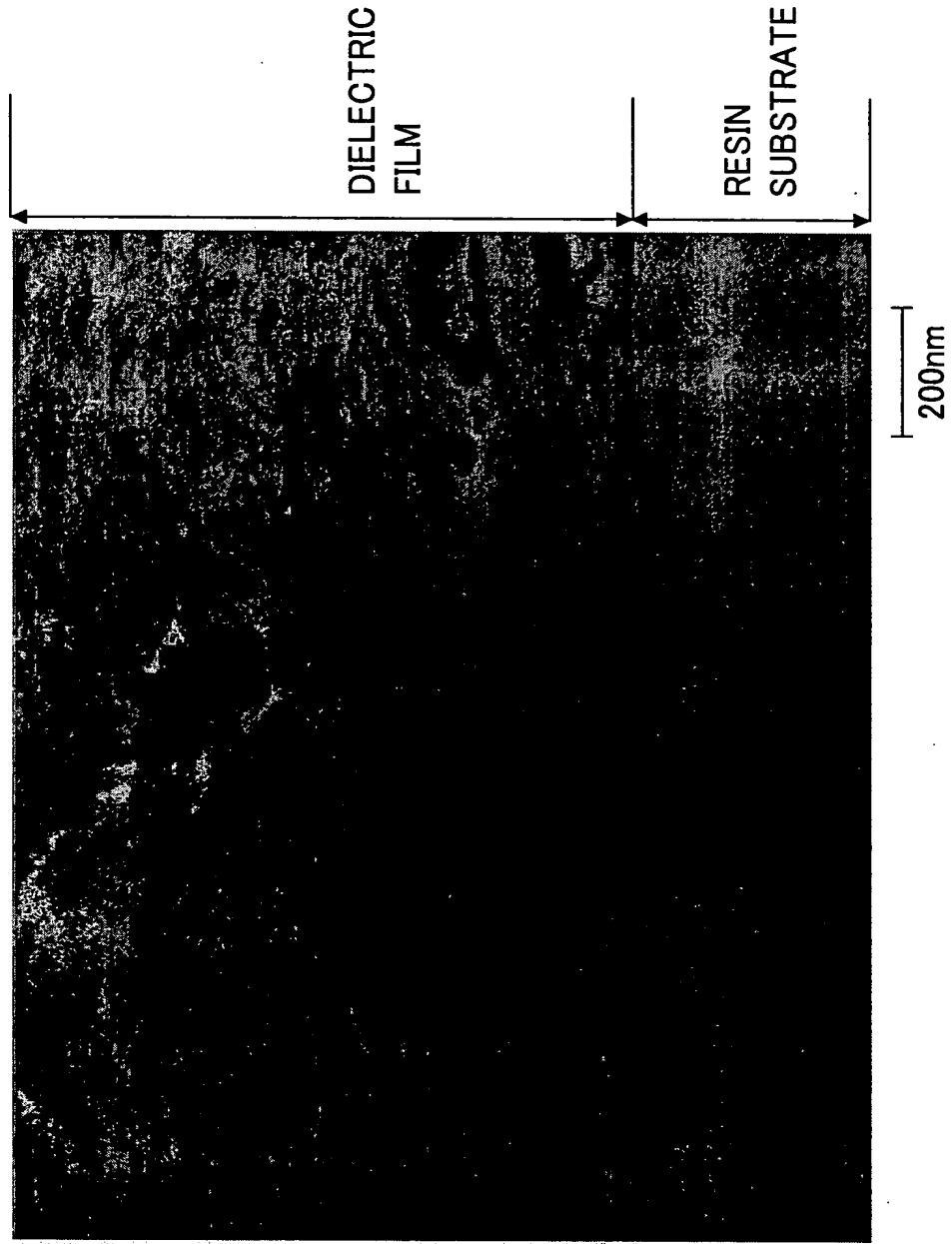


FIG.4

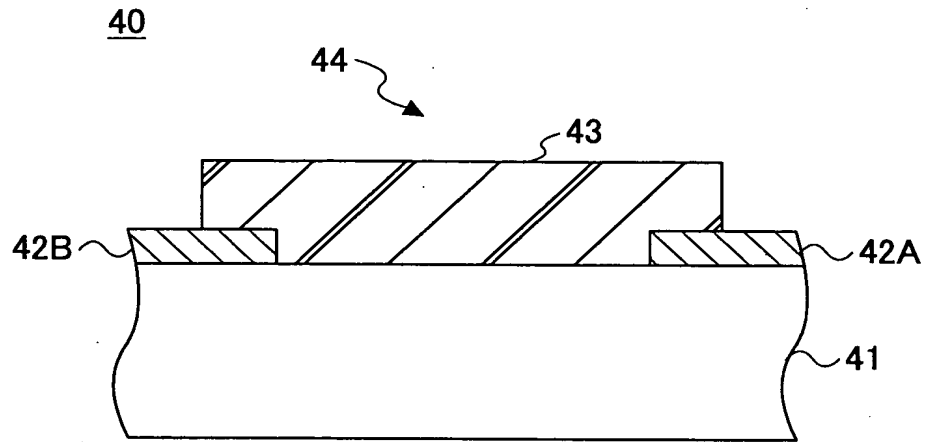


FIG.5

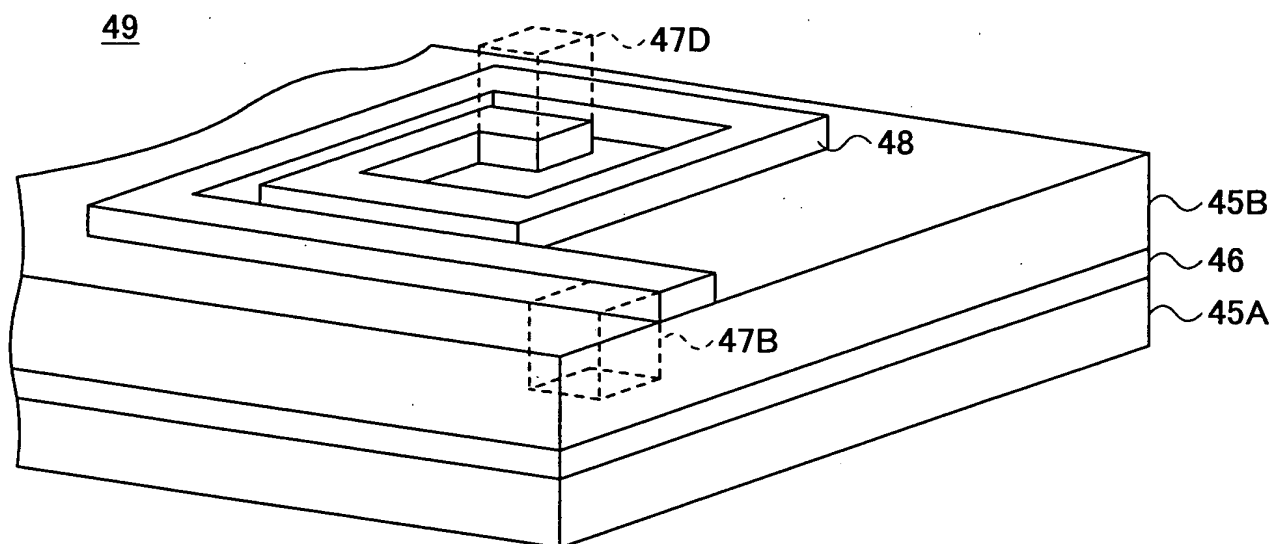


FIG.6

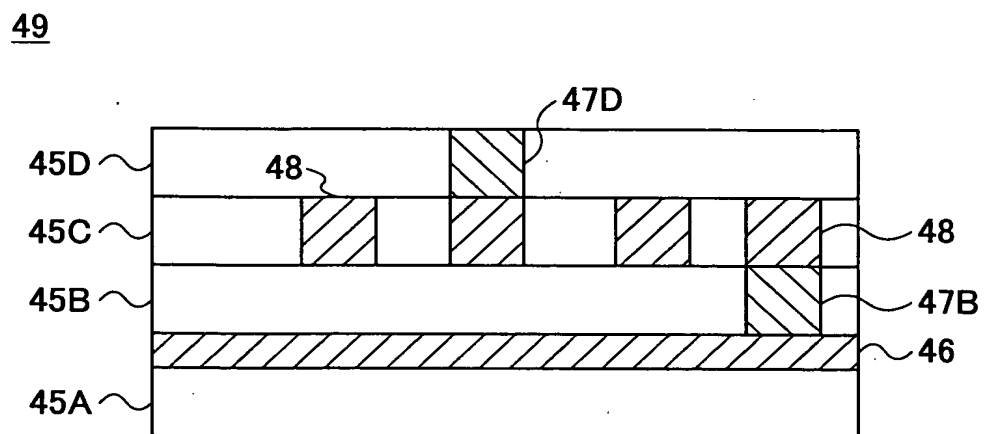


FIG. 7

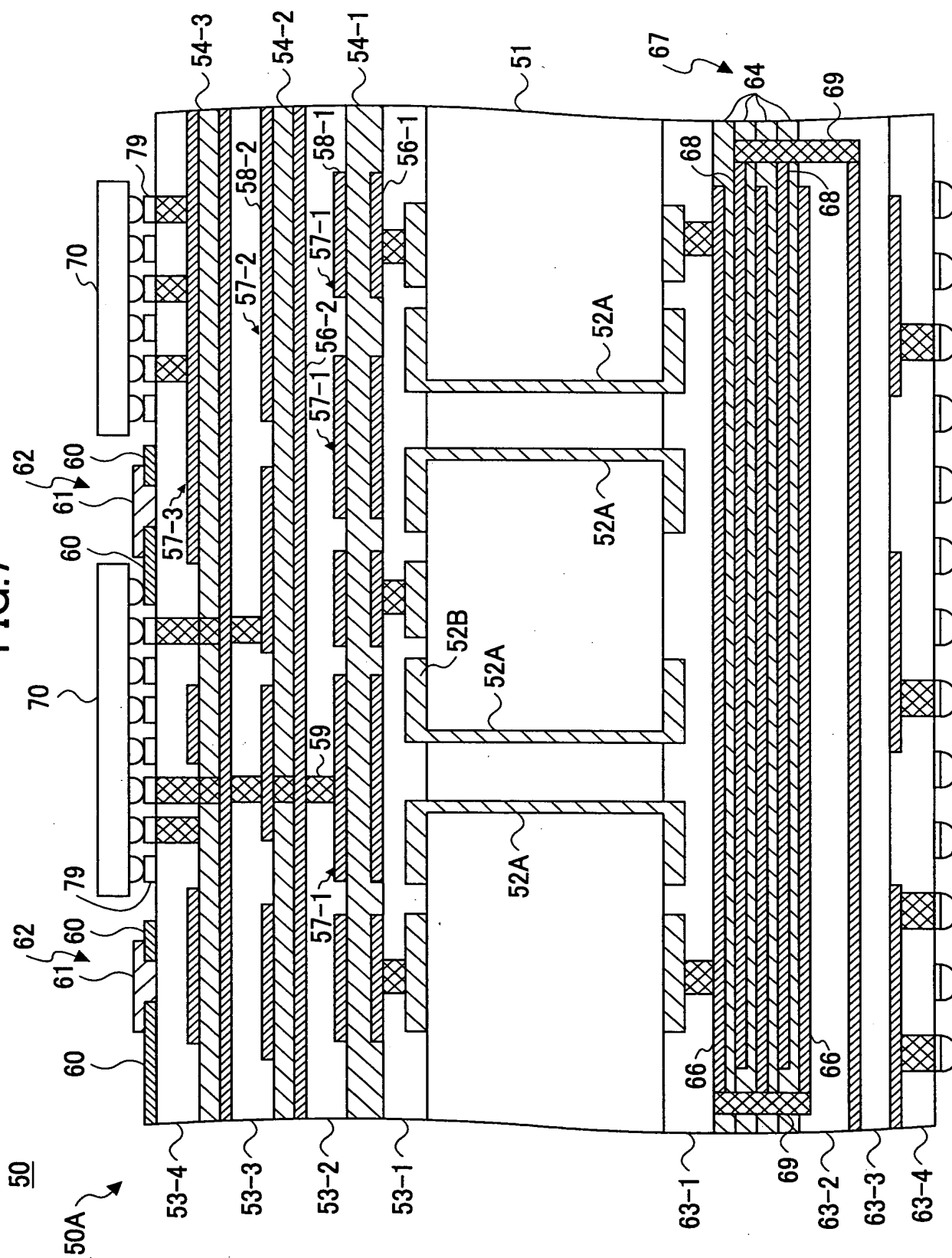


FIG.8A

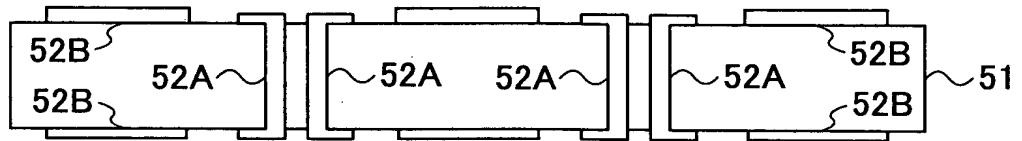


FIG.8B

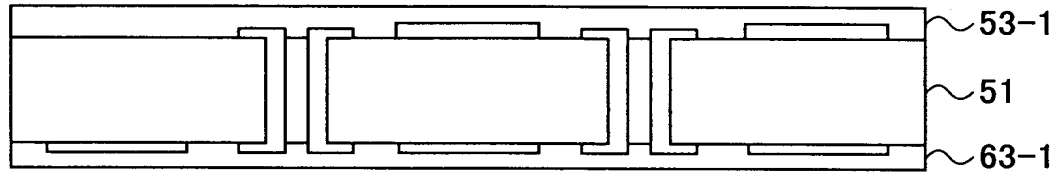


FIG.8C

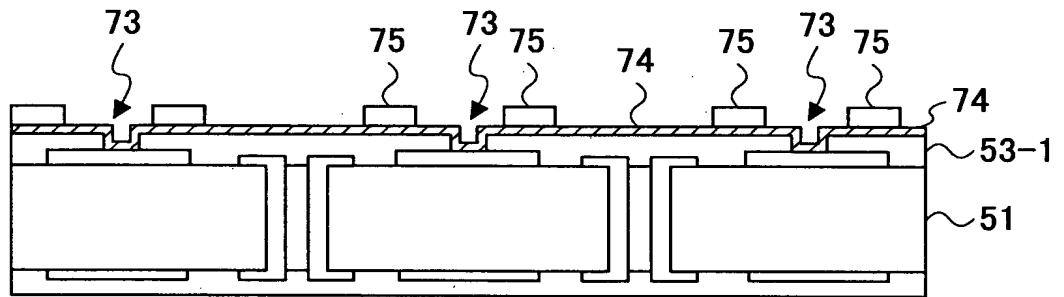


FIG.8D

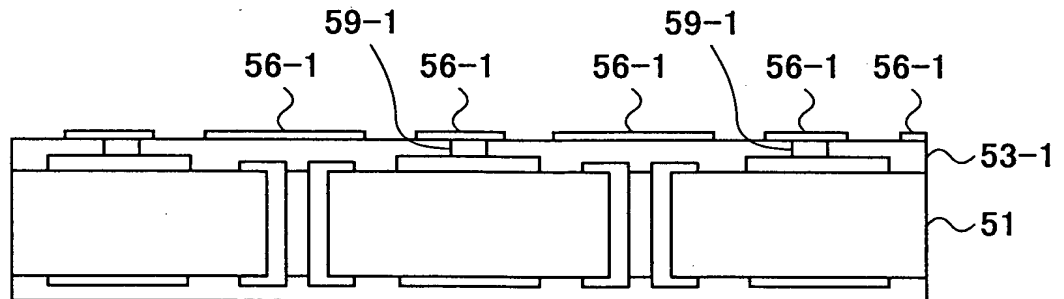


FIG. 8E

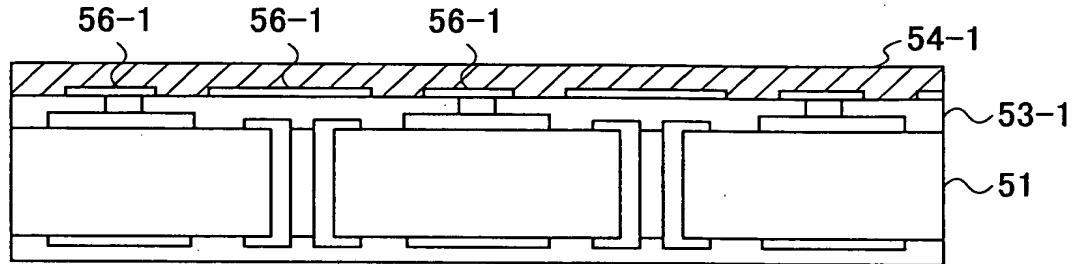


FIG. 8F

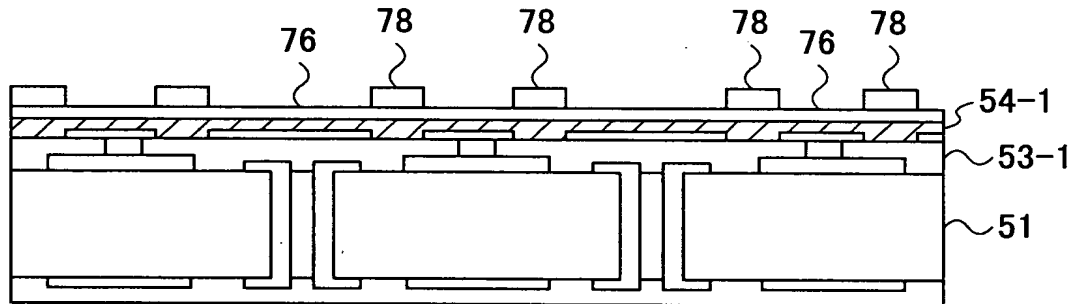


FIG. 8G

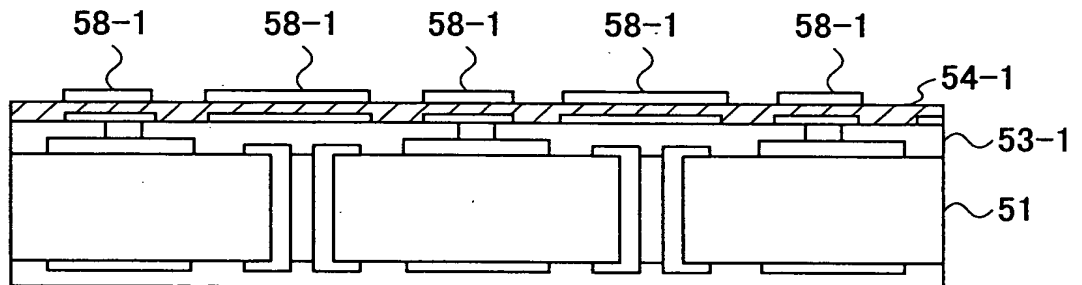


FIG. 8H

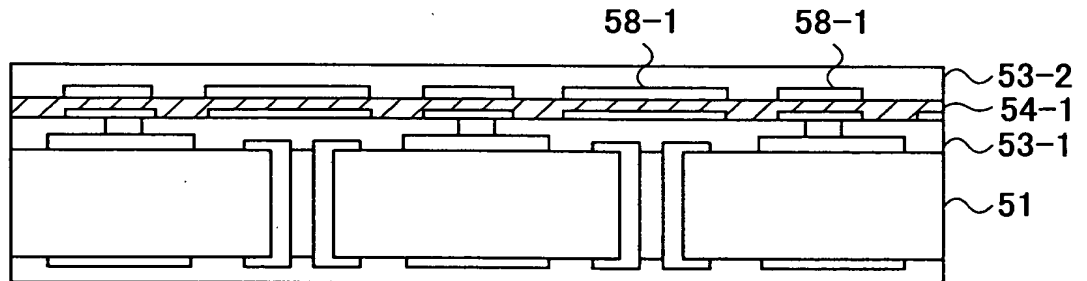


FIG. 9

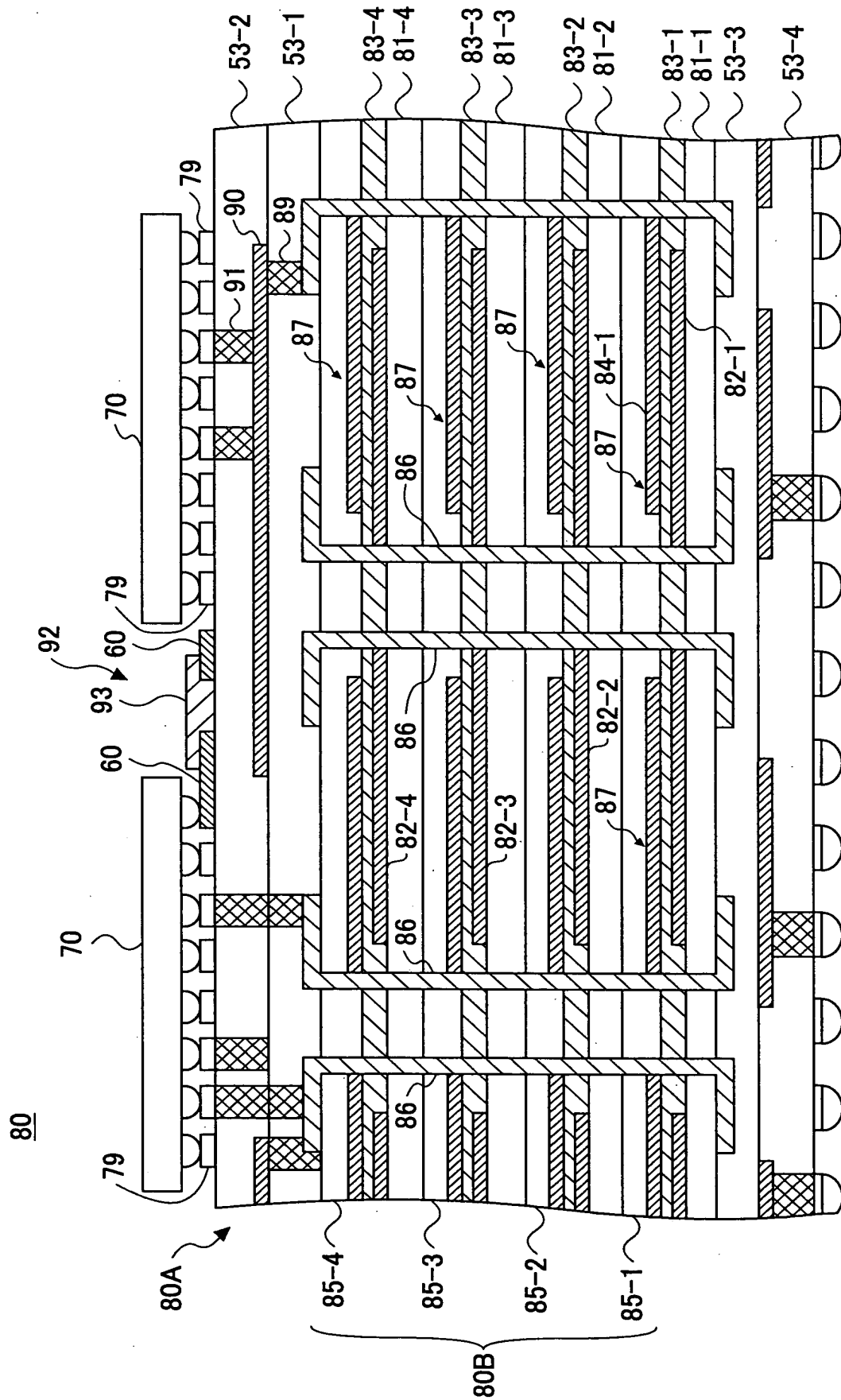


FIG.10

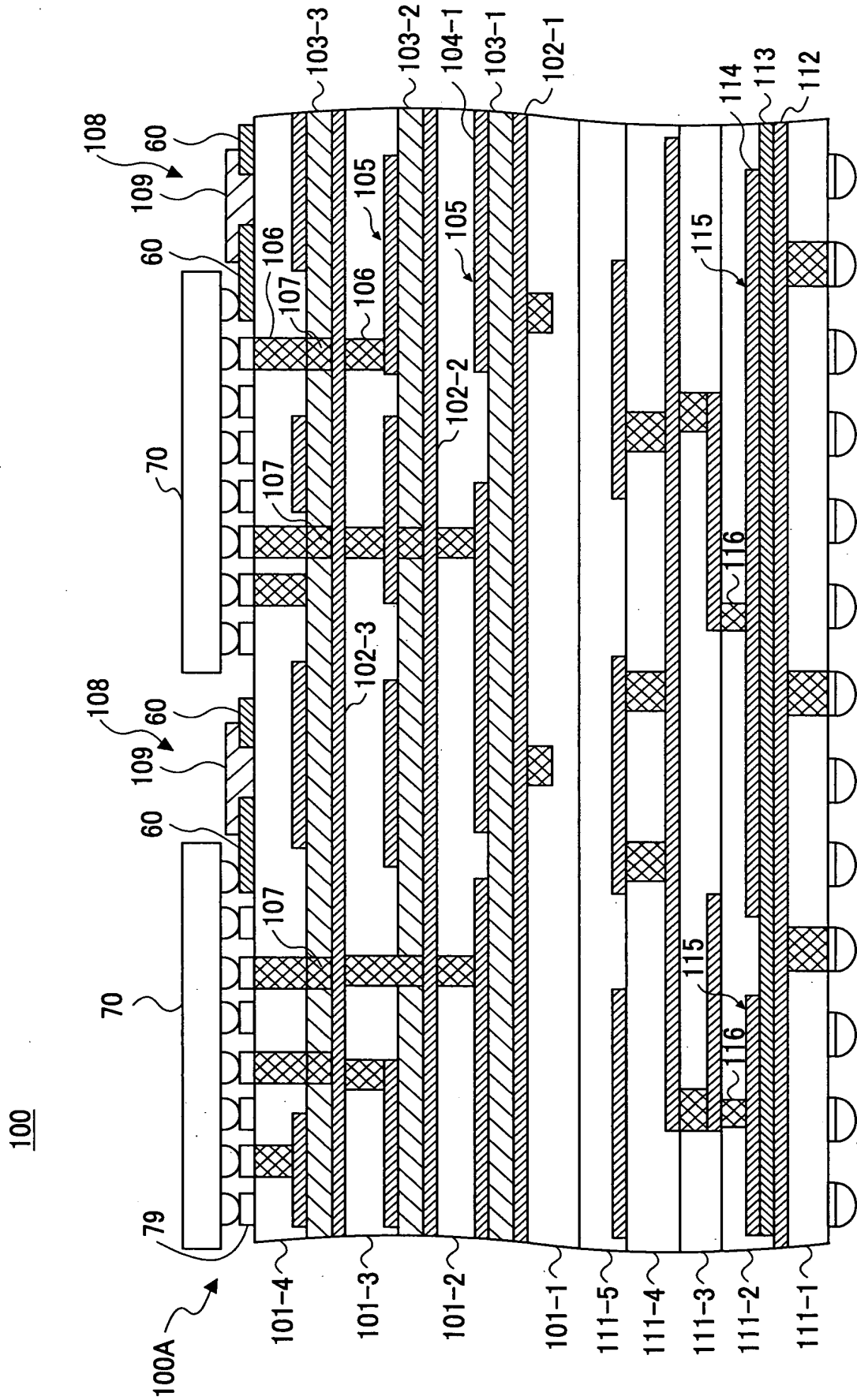


FIG.11A

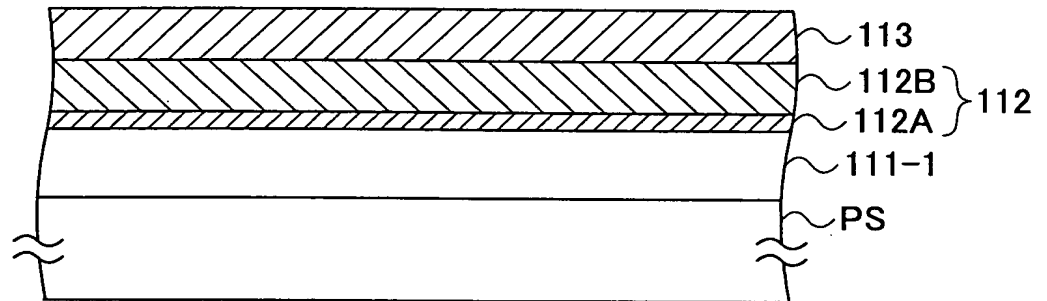


FIG.11B

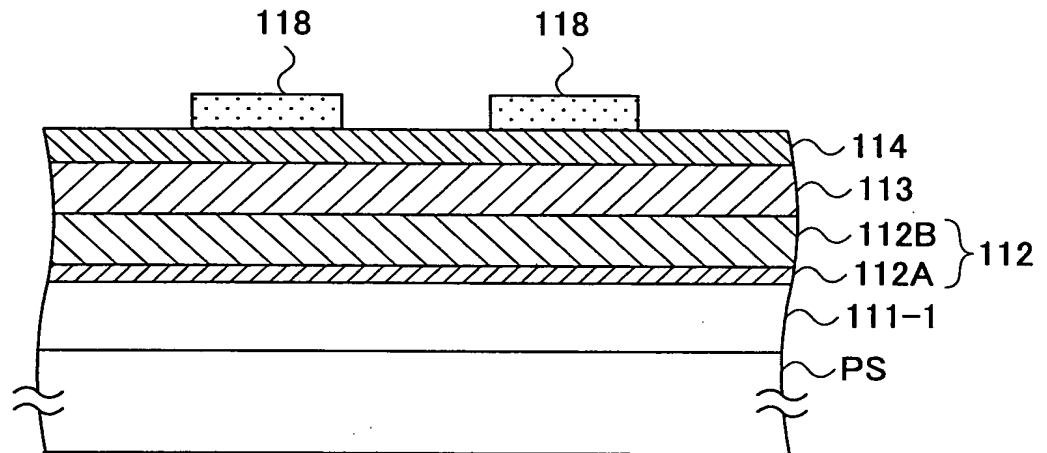


FIG.11C

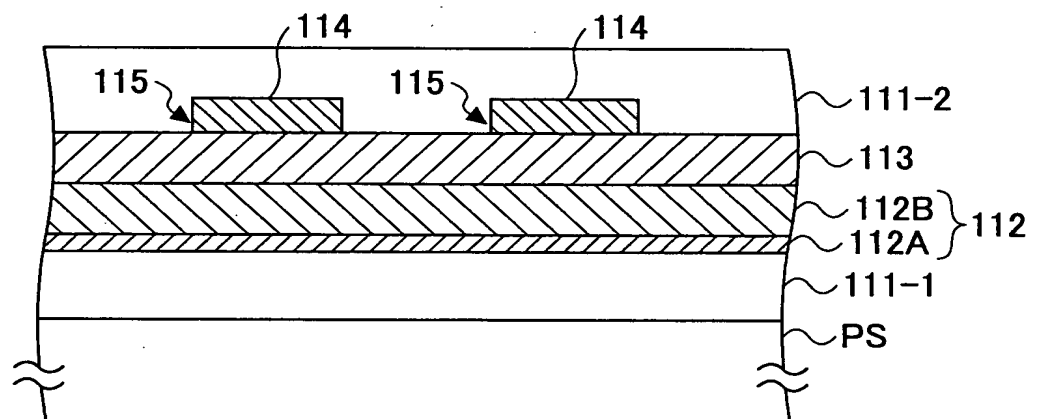


FIG.12

120

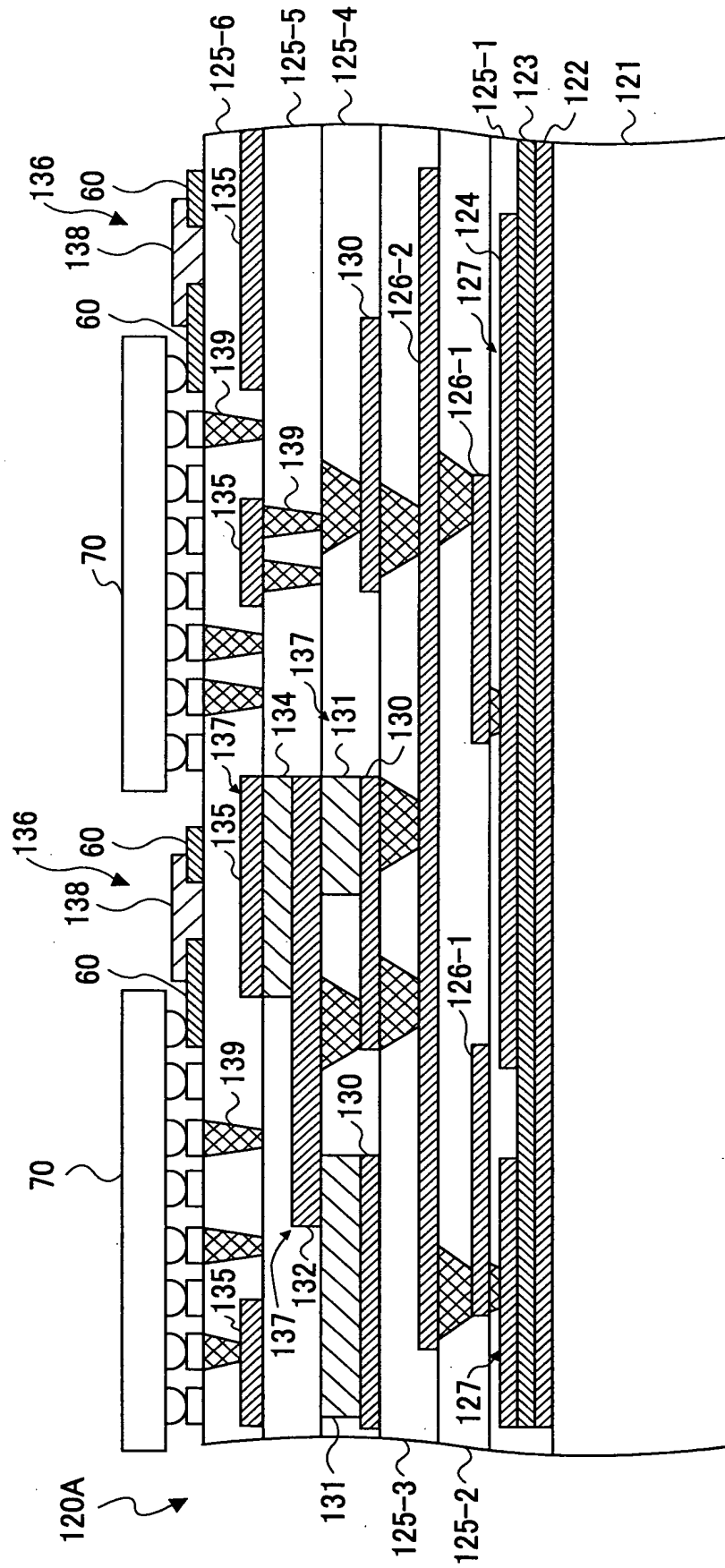


FIG. 13

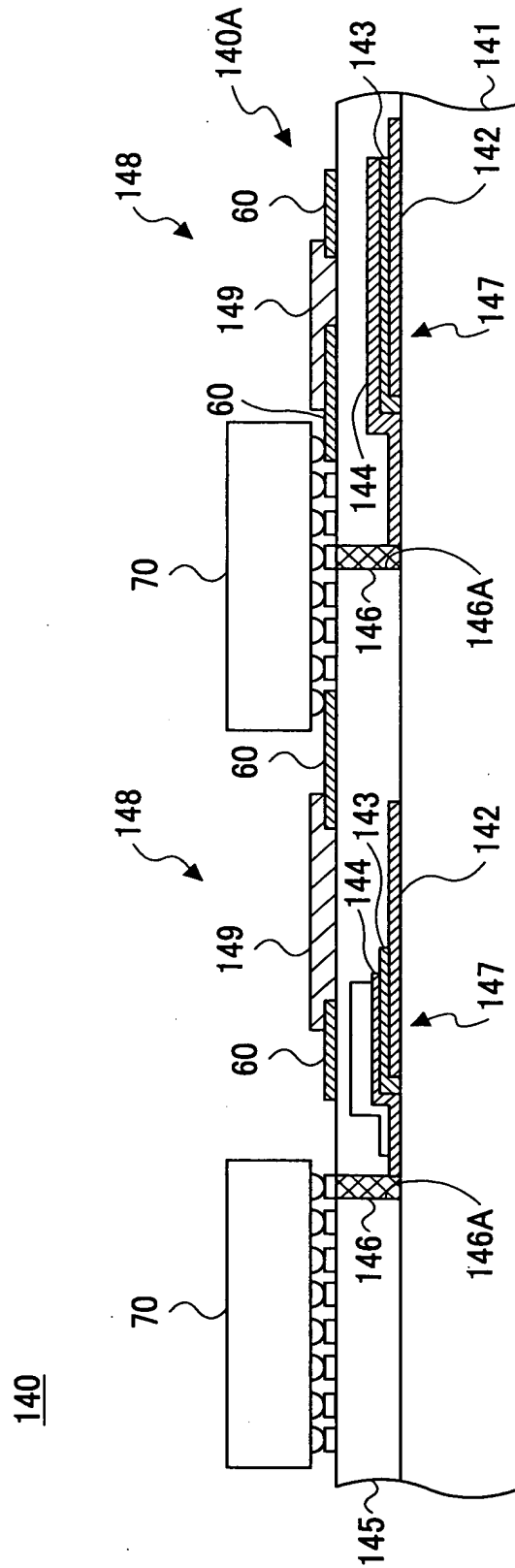


FIG.14

150

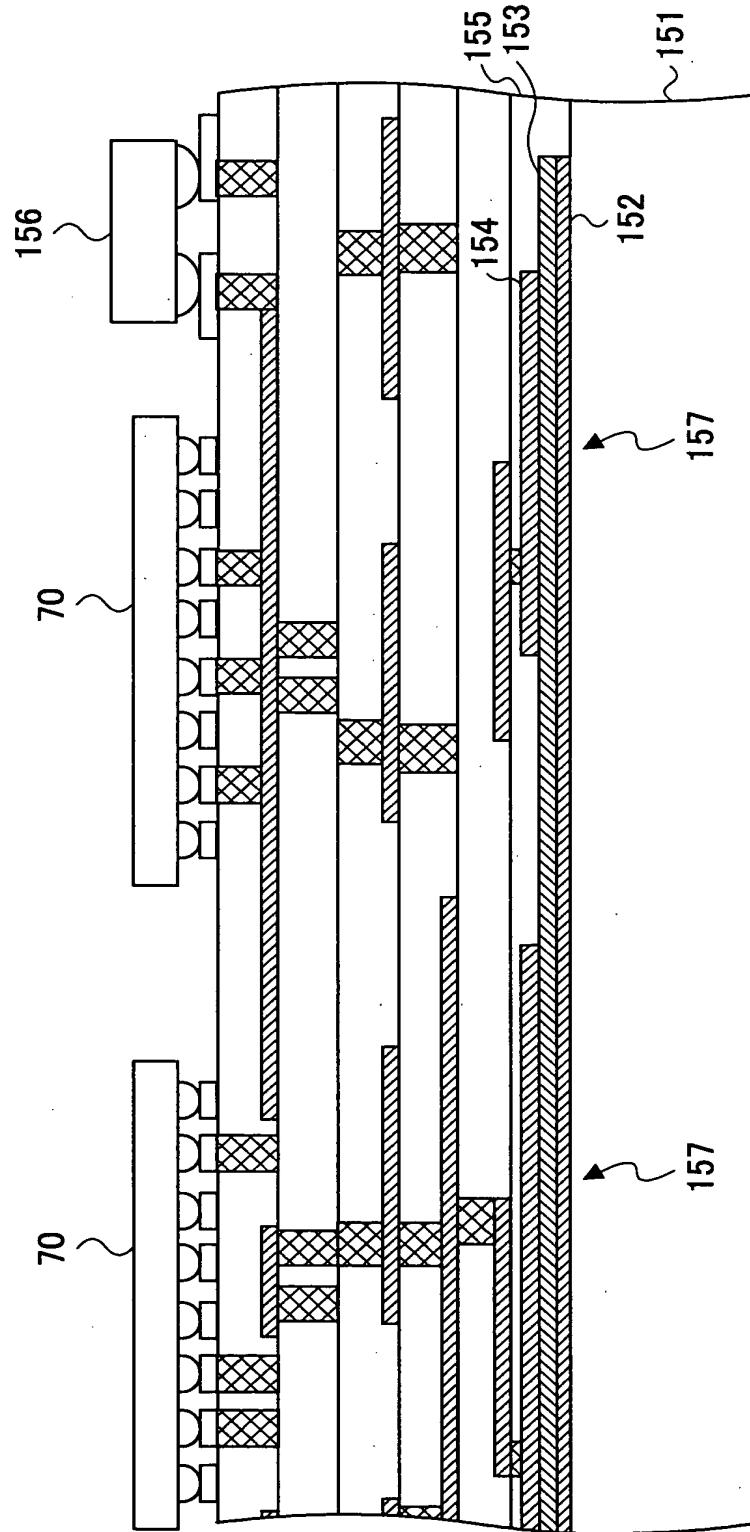


FIG.15

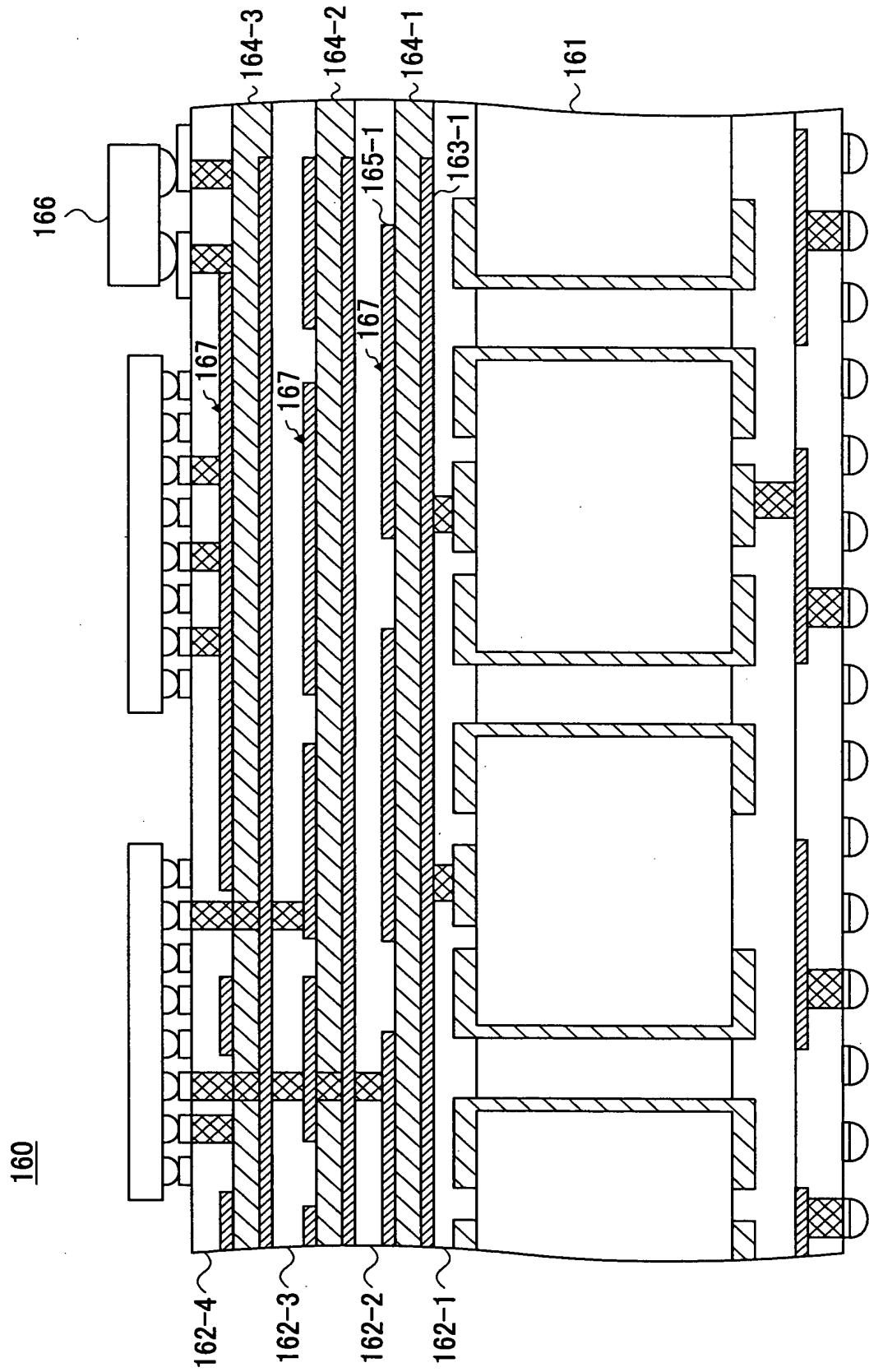


FIG.16

EXAMPLE	SUBSTRATE	INSULATOR	DIELECTRIC FINE PARTICLE	ALUMINA COAT	Ave. DIAMETER (μ m)	THICKNESS (μ m)	K (1GHz)	CAP. DENSITY (nF/cm ²)
1	FR-4	EPOXY	TiO ₂	YES	0.3	10	100	80
2	FR-4	EPOXY	BaTiO ₃	YES	0.1	10	1500	1300
3	FR-4	EPOXY	Al ₂ O ₃	NO	0.2	10	10	24
4	FR-4	EPOXY	TiO ₂	NO	0.3	10	80	65
5	FR-4	EPOXY	BaTiO ₃	YES	0.3	10	1500	2600
6	POLYIMIDE	POLYIMIDE	BaSrTiO ₃	YES	0.1	10	2000	1800
7	POLYIMIDE	POLYIMIDE	Ba ₂ Ti ₉ O ₂₀	YES	0.3	10	20	35
8	Si	POLYIMIDE	Ba ₂ Ti ₄ O ₉	YES	0.1	10	25	40
9	Si	POLYIMIDE	BaSrTiO ₃	YES	0.1	10	1500	1300
10	Si	POLYIMIDE	BaSrTiO ₃ & PbZrTiO ₃ MIX	NO	0.1	10	3000	5300
11	RESIN CASE	EPOXY		YES	0.3	10	80	50
COMP1	FR-4	POLYIMIDE	BaSrTiO ₃ SPUTTER	—	—	5	10	8
COMP2	FR-4	EPOXY	BaTiO ₃ & EPOXY MIX	—	0.1	100	30	0.3

FIG.17

EXAMPLE	RESISTANCE FINE PARTICLE	Ave. DIAMETER (μ m)	THICKNESS	ρ ($\mu \Omega \cdot \text{cm}$)
1	RuO ₂	0.01	10	16
6	SrRuO ₃	0.01	10	20
8	BiRuO ₃	0.01	10	30
11	Ta ₂ O ₅	0.01	10	80
12-1	NiCr	0.01	10	100
12-2	TaN	0.01	10	200
12-3	Ru	0.01	10	10
12-4	Ir	0.01	10	8
12-5	IrO ₂	0.01	10	20

FIG.18

EXAMPLE	PASSIVE COMP ON SUBSTRATE	SUBSTRATE AREA
1	5	0.6
5	4	0.4
6	5	0.5
8	3	0.4
11	10	0.4
COMP1	15	0.8
COMP2	20	1

FIG.19

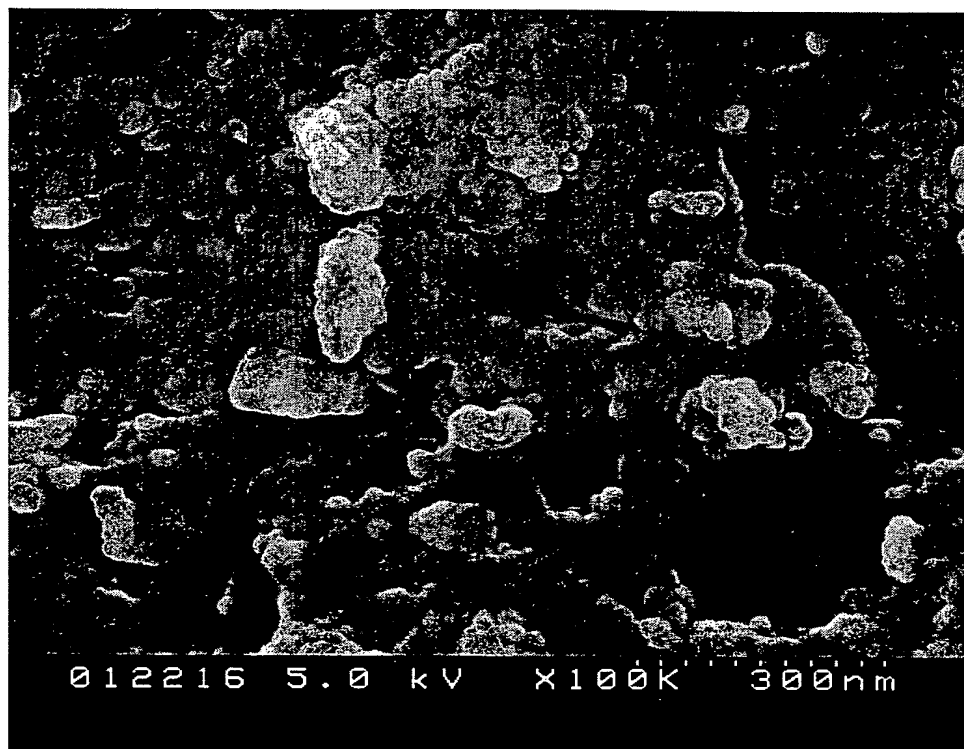


FIG.20

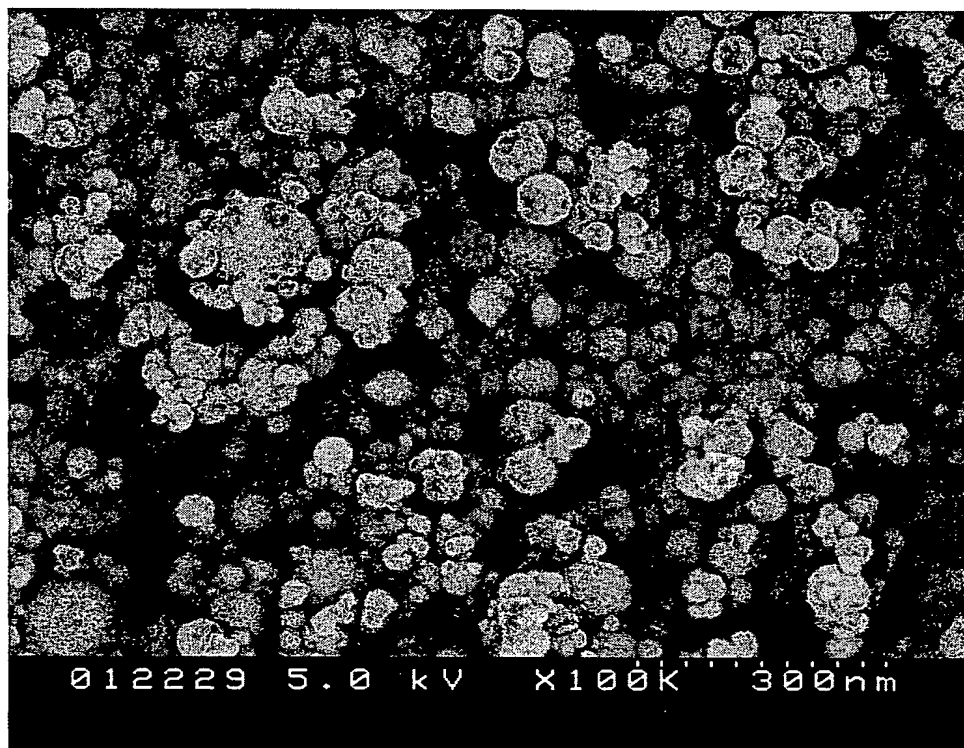


FIG.21

	FINE PARTICLE MATERIAL		MANUFACTURER	PRODUCT NAME	BINDER		THICKNESS (μ m)	SUBSTRATE	ADHERENCE (kg/mm ²)	WATER ABSORPTION (%)
	MATERIAL	Ave. DIAMETER (μ m)			COATING (MASS %)	BAKING				
EXAMPLE 13-1	TiO ₂	0.25	TAYCA	JR	5	YES	100	GLASS	≥ 5.0	≤ 0.1
EXAMPLE 13-2	MgO	0.5	KOJUNDO	—	5	YES	100	GLASS	≥ 5.0	≤ 0.1
EXAMPLE 13-3	SiO ₂	0.4	KOJUNDO	—	5	YES	100	GLASS	≥ 5.0	≤ 0.1
EXAMPLE 13-4	AlN	0.5	TOKUYAMA	GRADE F	5	YES	100	GLASS	≥ 5.0	≤ 0.1
EXAMPLE 13-5	PLZT	0.6	KOJUNDO	—	5	YES	100	GLASS	≥ 5.0	≤ 0.1
EXAMPLE 13-6	BaTiO ₃	0.20	SAKAI	BT	5	YES	60	FR-4	≥ 4.0	≤ 0.1
EXAMPLE 13-7	RuO ₂	0.05	KOJUNDO	—	5	YES	60	FR-4	≥ 4.0	≤ 0.1
EXAMPLE 13-8	IrO ₂	0.1	KOJUNDO	—	5	YES	60	FR-4	≥ 4.0	≤ 0.1
EXAMPLE 13-9	Cu	0.8	KOJUNDO	—	5	YES	60	FR-4	≥ 4.0	≤ 0.1
EXAMPLE 13-10	W	0.6	KOJUNDO	—	5	YES	60	FR-4	≥ 4.0	≤ 0.1
EXAMPLE 13-11	Al	0.8	KOJUNDO	—	5	YES	60	FR-4	≥ 4.0	≤ 0.1
EXAMPLE 13-12	TiC	0.5	KOJUNDO	—	5	YES	60	FR-4	≥ 4.0	≤ 0.1
EXAMPLE 13-13	TiO ₂	0.10	TAYCA	—	5	YES	60	FR-4	≥ 4.0	≤ 0.1
EXAMPLE 13-14	TiO ₂	0.05	TAYCA	—	5	YES	60	FR-4	≥ 4.0	≤ 0.1
EXAMPLE 13-15	TiO ₂	0.25	TAYCA	—	0.10	YES	60	FR-4	≥ 4.0	≤ 0.1
COMPARATIVE 1	TiO ₂	0.08	TAYCA	—	0.08	YES	30	FR-4	≤ 1.5	≥ 3
EXAMPLE 13-16	TiO ₂	0.25	TAYCA	—	5	NO	100	GLASS	≥ 5.0	≤ 0.1
EXAMPLE 13-17	TiO ₂	0.35	TAYCA	JR600A	2	—	100	GLASS	≥ 5.0	≤ 0.1

FIG.22

	FINE PARTICLE MATERIAL		MANUFACTURER	PRODUCT NAME	THICKNESS (μ m)	SUBSTRATE	ADHERENCE (kg/mm ²)	WATER ABSORPTION (%)
	MATERIAL	Ave. DIAMETER (μ m)						
EXAMPLE 14-1	TiO ₂	0.25	TAYCA	JR	40	FR-4	≥ 4.0	≤ 0.1
EXAMPLE 14-2	Ba(Mg _{1/3} Ta _{2/3})TiO ₃	0.20	KOJUNDO	—	60	GLASS	≥ 4.0	≤ 0.1
EXAMPLE 14-3	RuO ₂	0.05	KOJUNDO	—	5	FR-4	≥ 4.0	≤ 0.1

FIG.23

	FINE PARTICLE MATERIAL		MANUFACTURER	PRODUCT NAME	BINDER			THICKNESS (μm)	SUBSTRATE	ADHERENCE (kg/mm^2)	WATER ABSORPTION (%)
	MATERIAL	Ave. DIAMETER (μm)			MATERIAL	Ave. DIAMETER (μm)	AMOUNT (MASS%)				
EXAMPLE 15-1	TiO ₂	0.25	TAYCA	JR	Al ₂ O ₃	0.10	10	120	Ox-free Cu	≥ 4.5	≤ 0.1
EXAMPLE 15-2	AlN	0.80	TOKUYAMA	GRADE F	PZT	0.50	5	100	GLASS	≥ 4.0	≤ 0.1
EXAMPLE 16	TiO ₂	0.25	TAYCA	JR	Al ₂ O ₃	0.10	50	100	Si	≥ 5.0	≤ 0.1
EXAMPLE 17	TiO ₂	0.25	TAYCA	JR	Al ₂ O ₃	0.10	50	100	Si	≥ 5.0	≤ 0.1

FIG.24

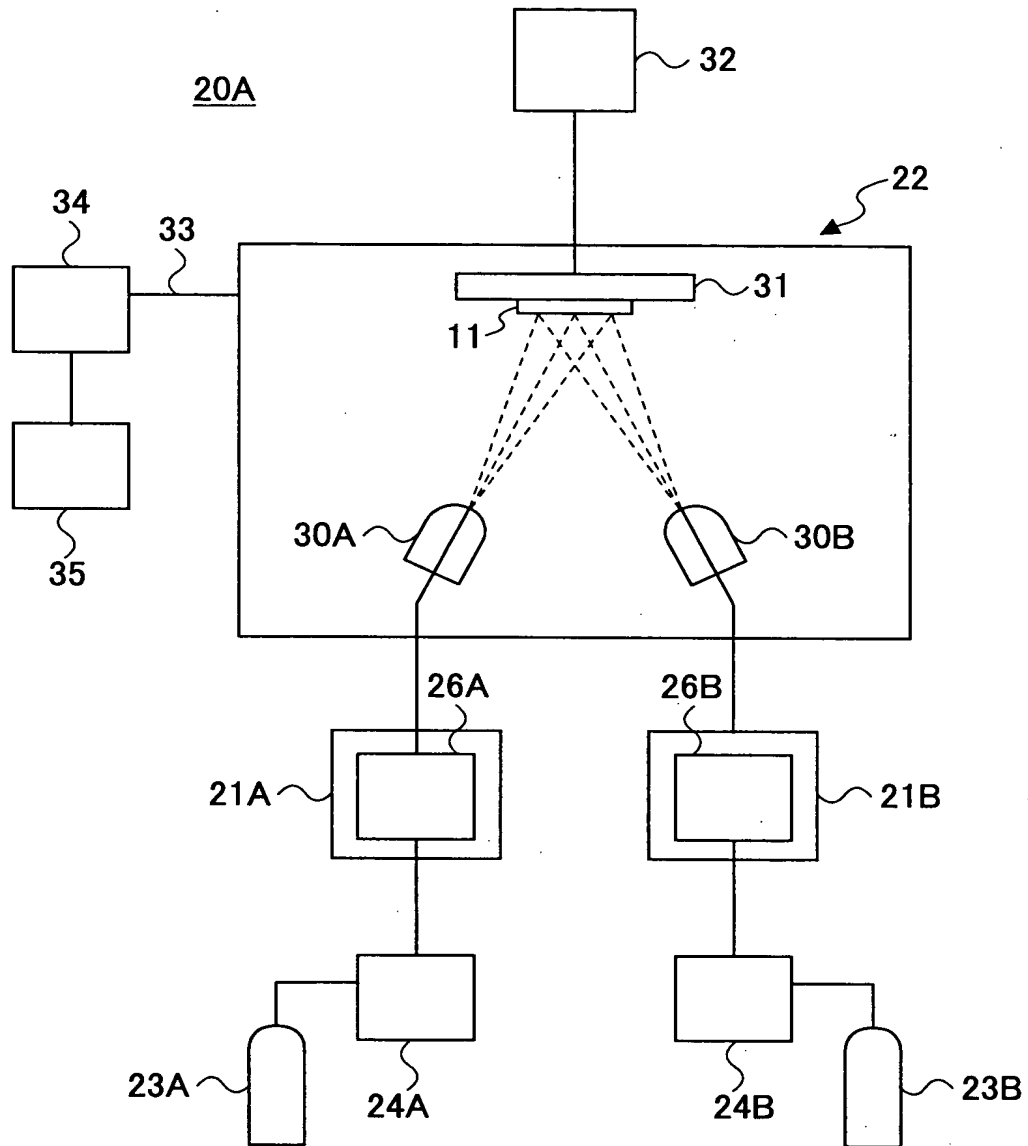
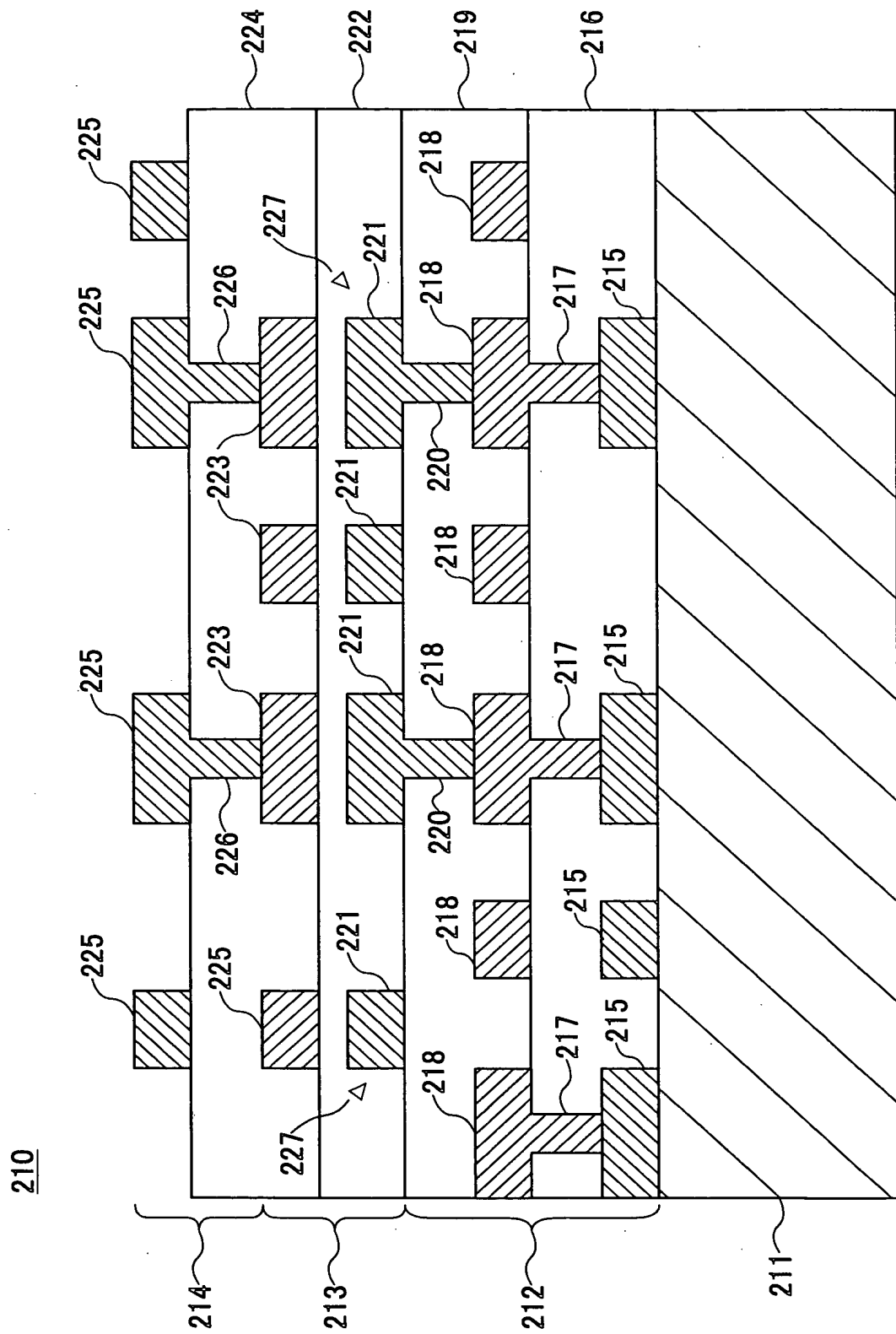
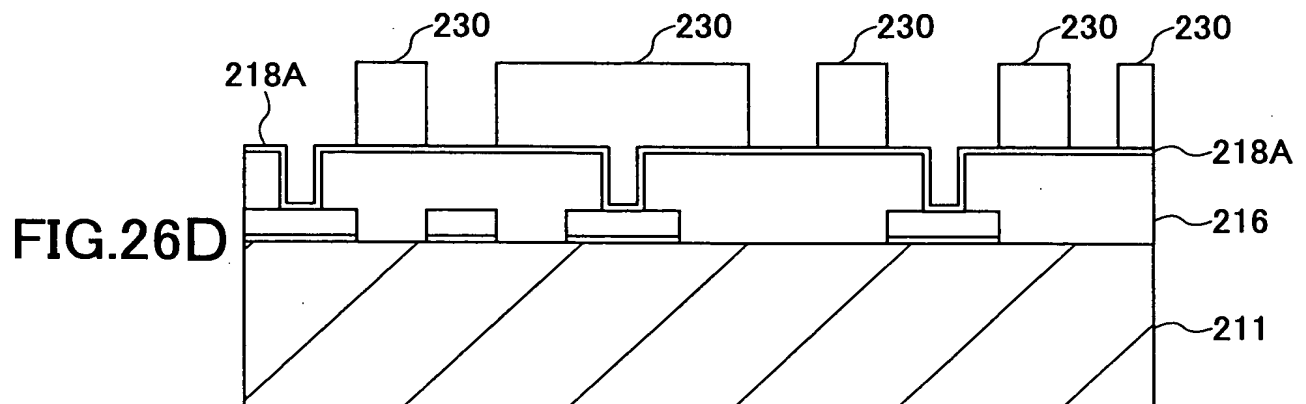
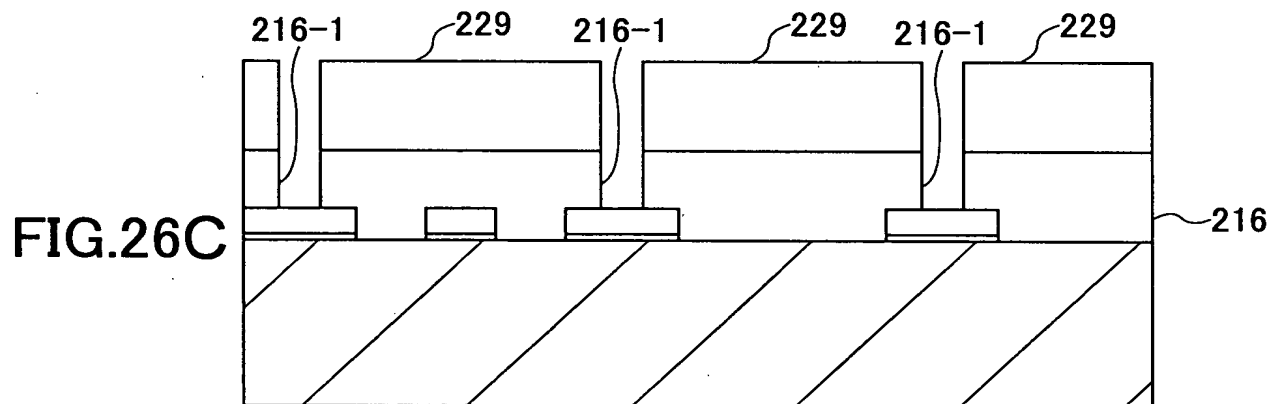
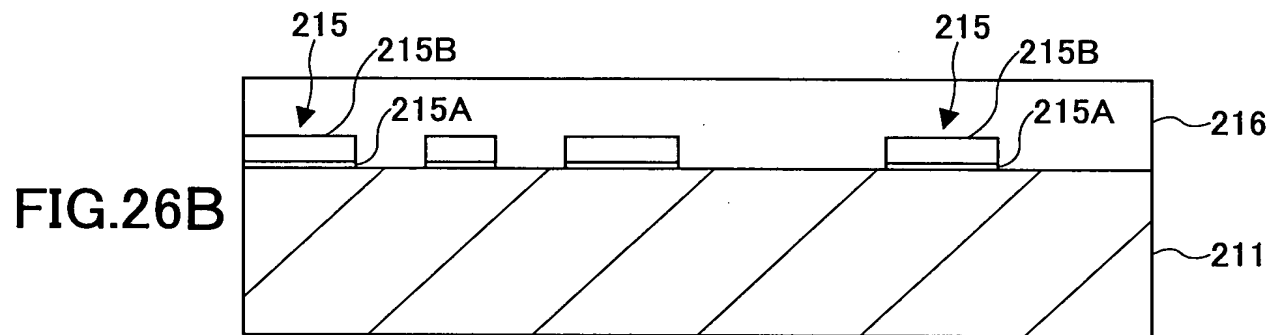
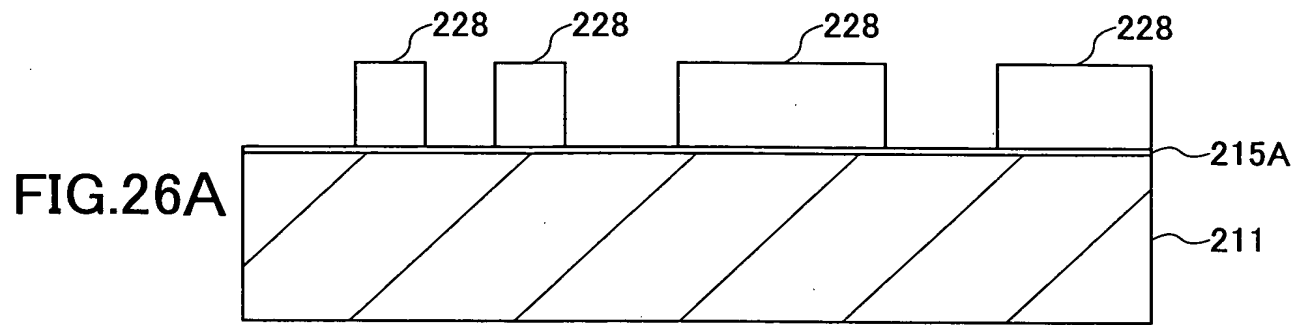


FIG. 25





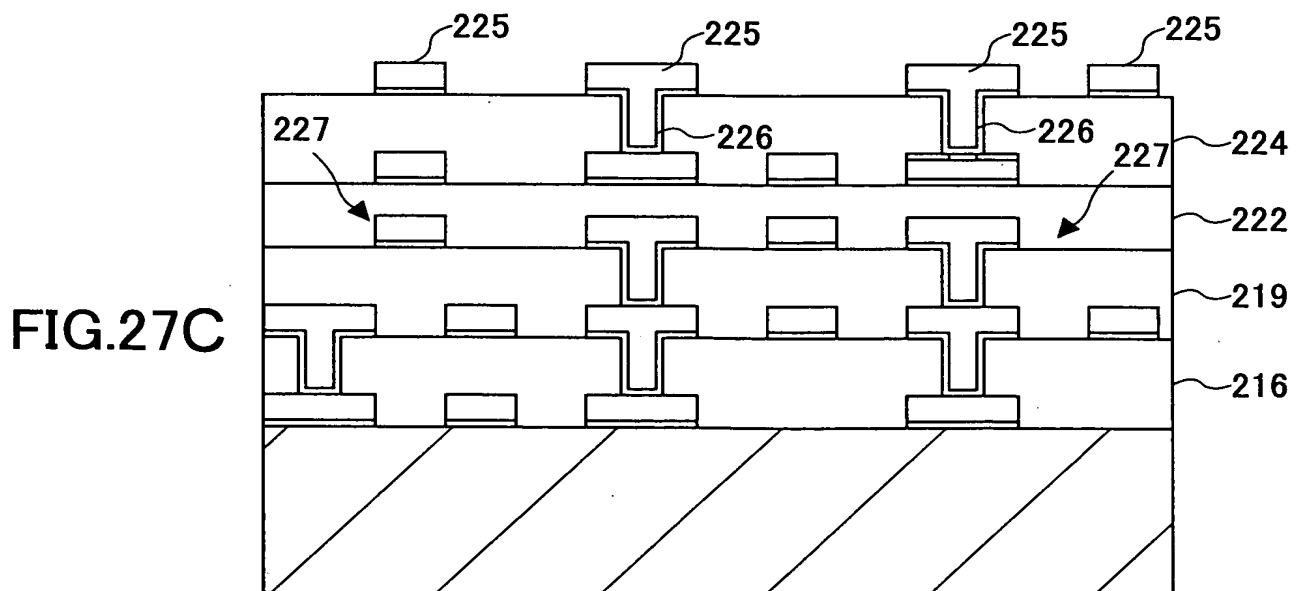
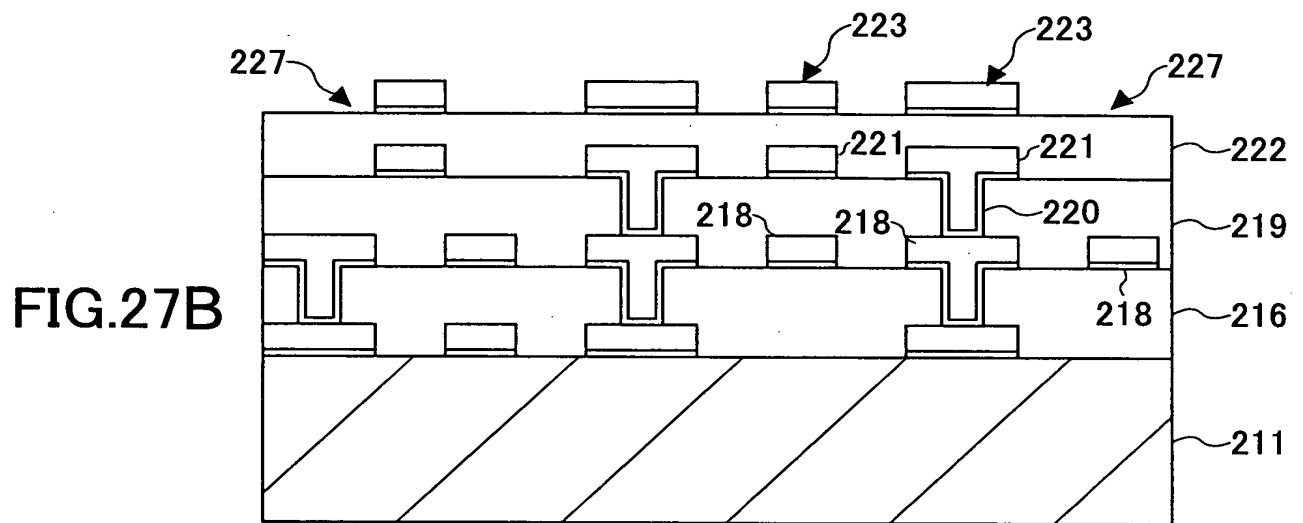
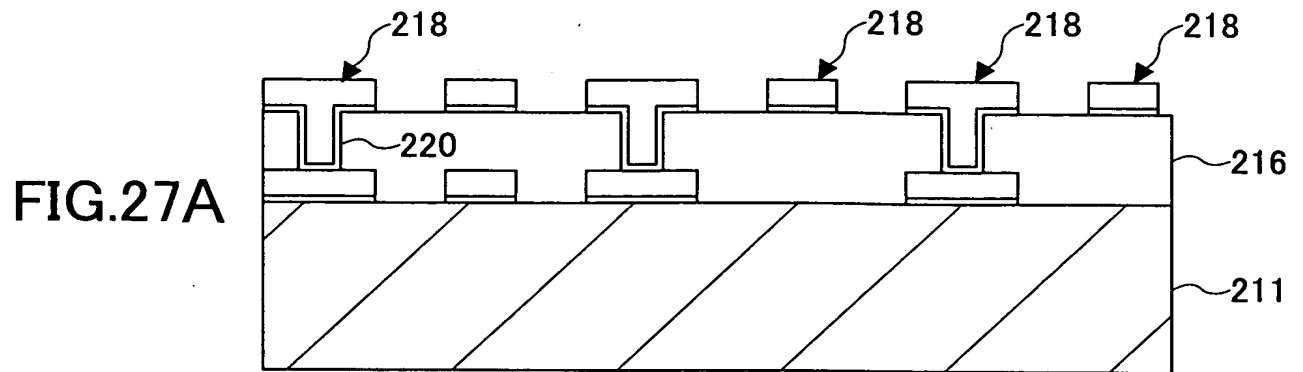


FIG.28

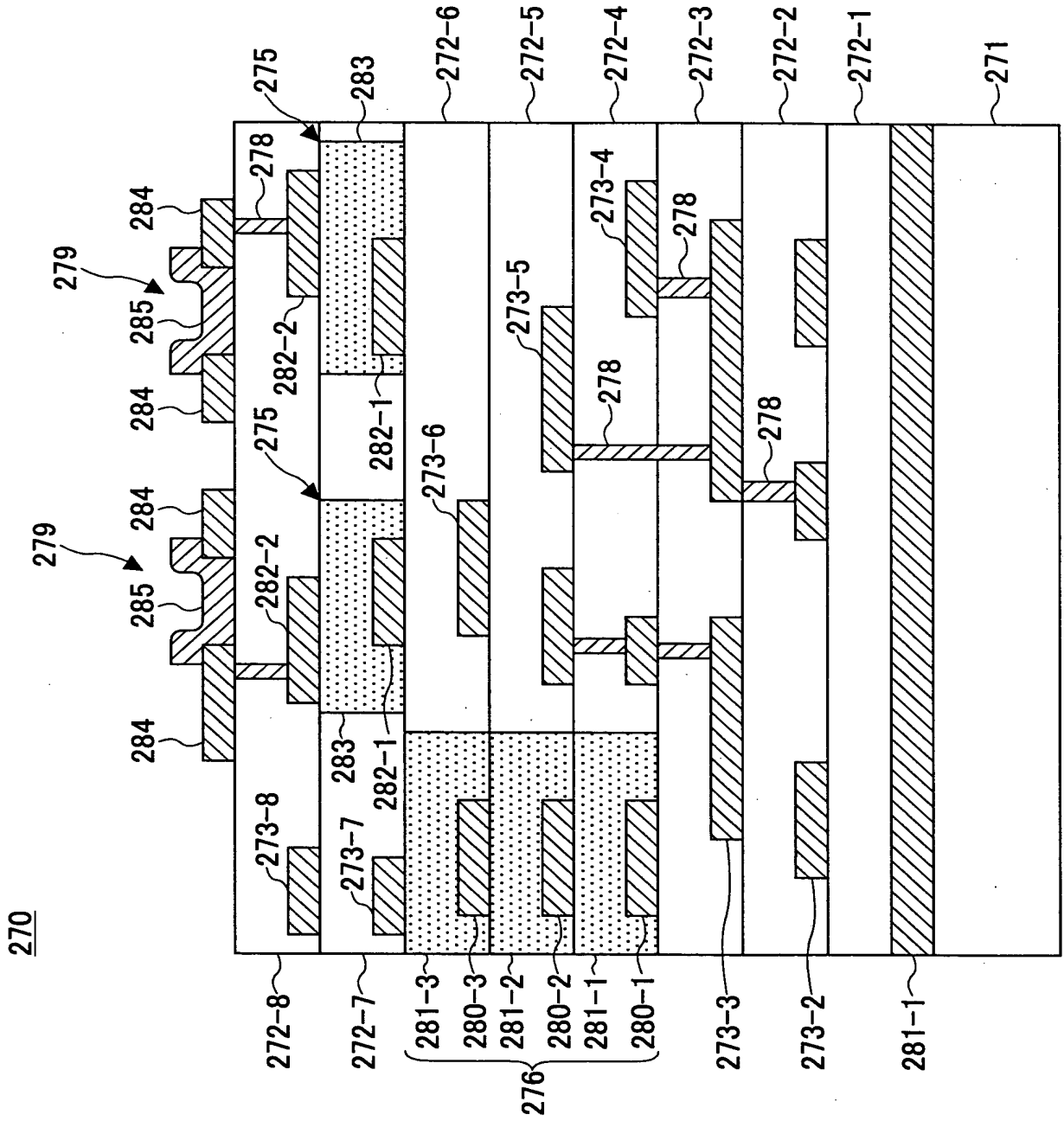


FIG.29

290

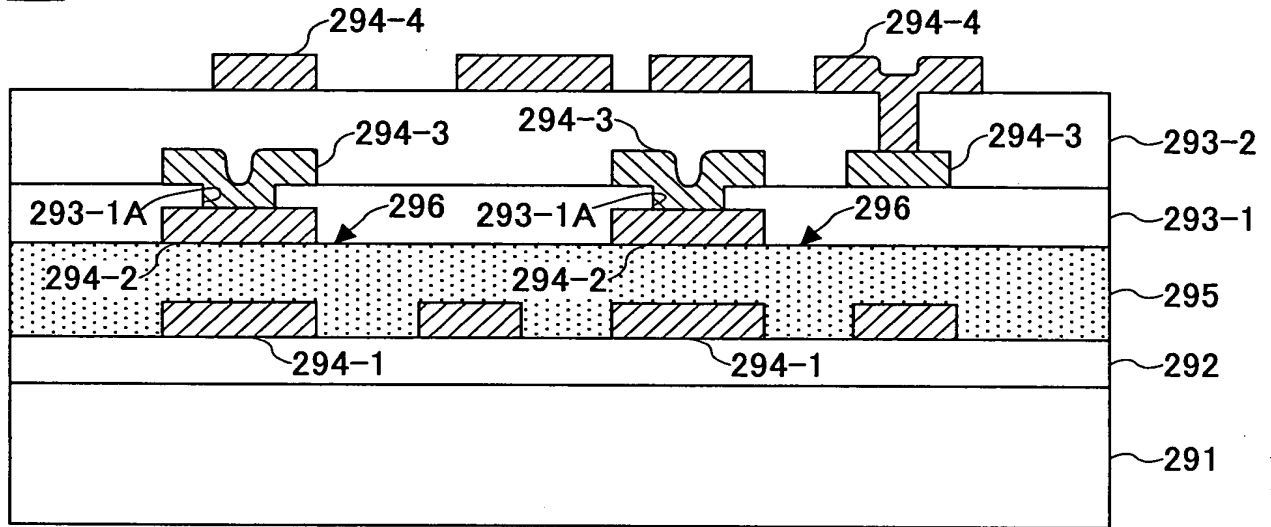


FIG.30

300

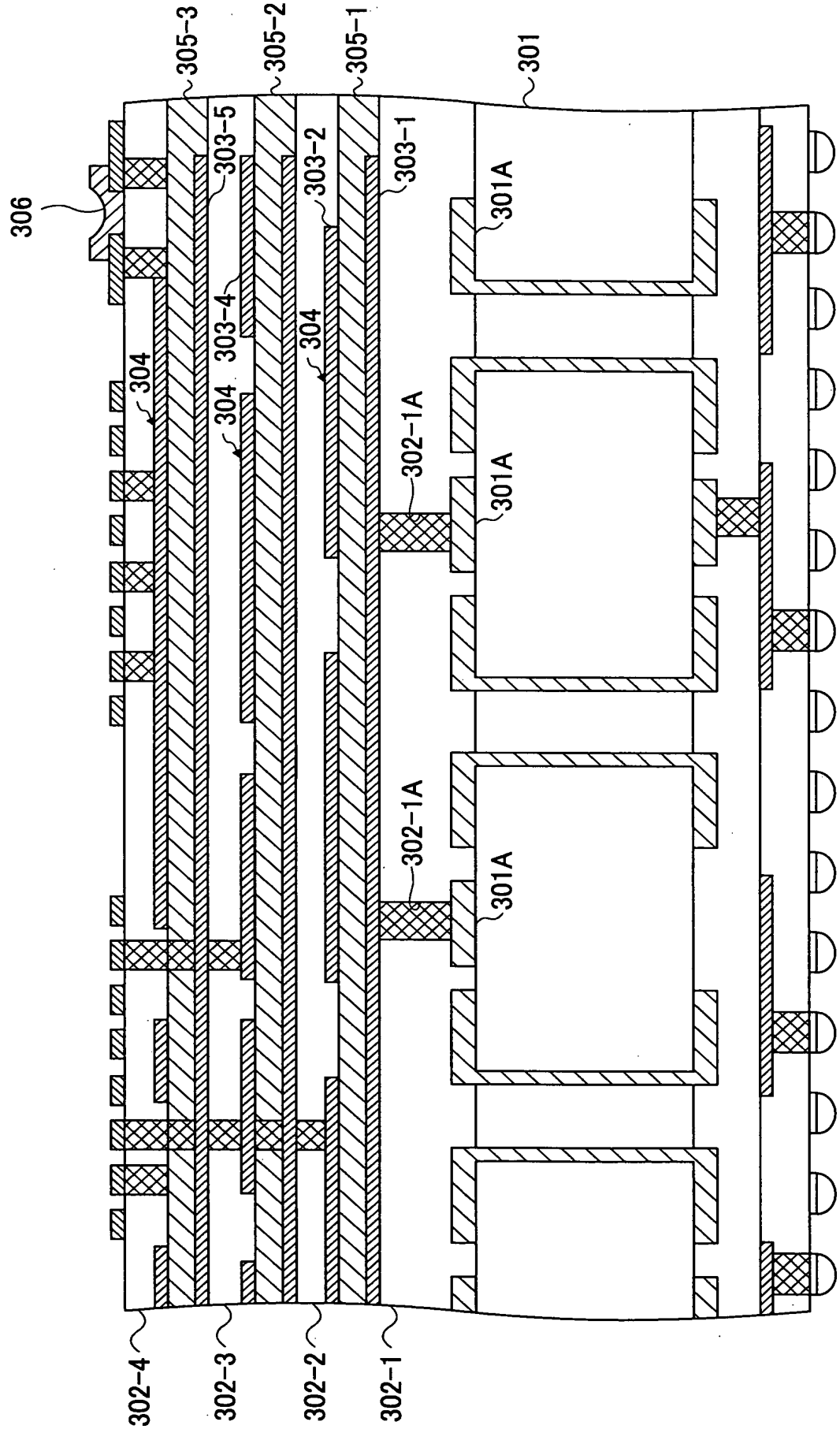


FIG.31

310

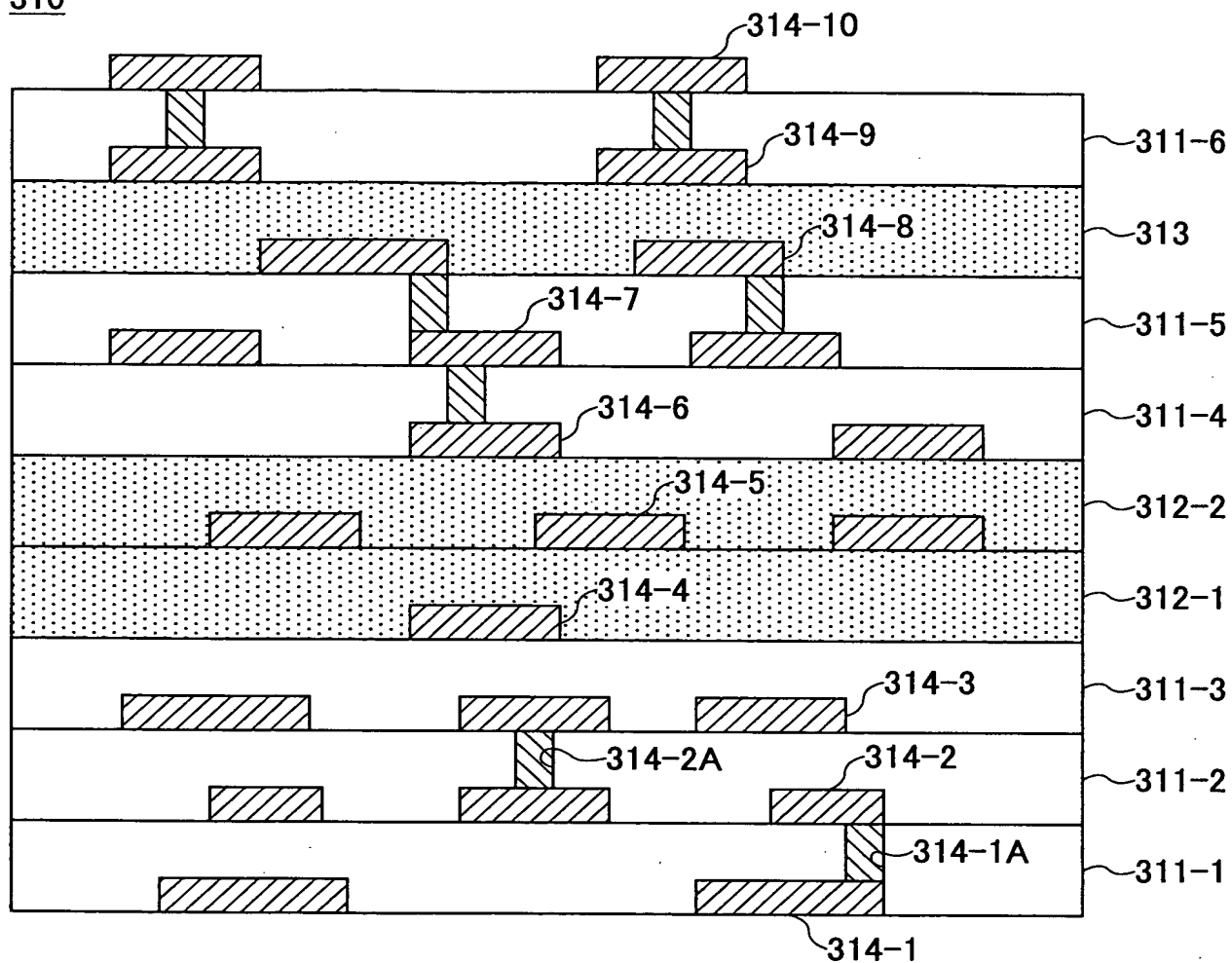


FIG.32

	INTERLAYER INSULATION FILM				CONDUCTOR LAYER		HIGH FREQ LOSS
	MATERIAL	SURFACE TREATMENT	Ave. DIAMETER (μ m)	$\tan \delta$	MATERIAL	ρ ($\mu \Omega \cdot \text{cm}$)	
EXAMPLE 18	MgO	Al ₂ O ₃ COAT	0.25	0.0003	Cu PLATING	2	0.6
EXAMPLE 19	MULLITE	Al ₂ O ₃ COAT	0.8	0.0004	Cu PLATING	2	0.6
EXAMPLE 20	Ba(Mg _{1/3} Ta _{2/3})TiO ₃	ALUMINUM ISOPROPOXIDE	0.8	0.00025	Cu PLATING	2	0.6
EXAMPLE 21	AlN	ALUMINUM ISOPROPOXIDE	1.0	0.0005	Cu PLATING	2	0.7
COMPARATIVE EXAMPLE 4	POLYIMIDE	—	—	0.0025	Cu PLATING	5	0.8
COMPARATIVE EXAMPLE 5	GLASS EPOXY	—	—	0.0125	Cu PLATING	2	1
COMPARATIVE EXAMPLE 6	GLASS · ALUMINA LTCC	—	—	0.001~0.003	CuAg THICK FILM	8	0.8

FIG.33

	MATERIAL	SURFACE TREATMENT	Ave. DIAMETER (μ m)	K (2GHz)	$\tan \delta$
EXAMPLE 18	Ba(Mg _{1/3} Ta _{2/3})O ₃	Al ₂ O ₃ COAT	0.25	20	0.00025
EXAMPLE 19	BaTi ₄ O ₉	Al ₂ O ₃ COAT	0.1	25	0.0003
COMPARATIVE EXAMPLE 6	Ba(Mg _{1/3} Ta _{2/3})O ₃ -GLASS COMPOSITE	—	—	15	0.00125

FIG.34

	MATERIAL	SURFACE TREATMENT	Ave. DIAMETER (μ m)	E (2GHz)	CAPACITANCE DENSITY	RELATIVE SUBSTRATE SIZE
EXAMPLE 18	BaTiO ₃	Al ₂ O ₃ COAT	0.5	800	10	0.3
EXAMPLE 19	BaSrTiO ₃	Al ₂ O ₃ COAT	0.1	2000	20	0.3
COMPARATIVE EXAMPLE 4	BaSrTiO ₃ -SPUTTER FILM	—	—	300	5	0.6
COMPARATIVE EXAMPLE 5	BaTiO ₃ -EPOXY COMPOSITE FILM	—	—	50	1	1
COMPARATIVE EXAMPLE 6	CaZrO ₃ -GLASS COMPOSIT	—	—	200	10	0.8

FIG.35

